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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/784,821	02/24/2004	Yoshihisa Iba	042139	8491
38834	7590	06/29/2005	EXAMINER	
WESTERMAN, HATTORI, DANIELS & ADRIAN, LLP 1250 CONNECTICUT AVENUE, NW SUITE 700 WASHINGTON, DC 20036			NGUYEN, HA T	
			ART UNIT	PAPER NUMBER
			2812	

DATE MAILED: 06/29/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

**Application No.**

10/784,821

**Applicant(s)**

IBA, YOSHIHISA

**Examiner**

Ha T. Nguyen

**Art Unit**

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 31 May 2005.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-25 is/are pending in the application.
- 4a) Of the above claim(s) 1 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 2-25 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 24 February 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date 02-24-4.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

### DETAILED ACTION

1. Applicants' election of Group II, claims 2-25, without traverse in the paper filed May 31, 2005, is acknowledged. Non-elected claim 1 is therefore withdrawn from consideration.

#### *Claim Rejections - 35 USC § 103*

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(a) and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 2-7, 12-14, 16, 17, 19, 20, 22, 23, and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicants' admitted prior art (hereinafter "APA") in view of Tonegawa et al. (USPAPN 2003/0155657 A1, hereinafter "Tonegawa").

Referring to Figs. 8A-8D and related text, APA discloses [Re claim 2] a method of fabricating a semiconductor device, comprising the steps of: forming an SiC barrier film 103 over an interconnection 102; forming an interlayer dielectric film containing Si, C, and O 104-105 over the SiC barrier film, the examiner interpreted that at least at the interfaces of layer 105 with silica and SiO<sub>2</sub>, layers of Si, C, O are formed; forming a hole reaching the SiC barrier film in the interlayer dielectric film (see Fig. 8C); etching the SiC barrier film to allow the hole to reach the interconnection; and burying a conductive material in the hole (See pars. [0009]-[0010])

). But it fails to disclose expressly performing plasma processing using a hydrogen-containing gas on side surfaces of the interlayer dielectric film, the side surfaces being exposed to the hole; [Re claim 3] wherein a gas containing at least  $H_2$  gas is used as the hydrogen-containing gas; [Re claim 4] wherein a gas containing at least  $NH_3$  gas is used as the hydrogen-containing gas; [Re claim 5] wherein the side surfaces of the interlayer dielectric film is modified by the plasma processing, thereby increasing a selectivity to the SiC barrier film; [Re claim 7] wherein the plasma processing is performed by supplying a gas containing  $N_2$  gas and not substantially containing oxygen into a processing chamber in addition to the hydrogen-containing gas. However, the missing limitations are well known in the art because Tonegawa discloses these features (See pars. [0067]-[0068] ). A person of ordinary skill is motivated to modify APA with Tonegawa to obtain better adhesion.

[Re claim 6] Tonegawa also discloses wherein a thickness of the side surfaces to be modified by the plasma processing is not more than 10 nm (see Table 5).

[Re claim 12] The combined teaching of APA and Tonegawa discloses a method of fabricating a semiconductor device, comprising the steps of: forming an SiC barrier film over an interconnection; forming an interlayer dielectric film containing and O over the SiC barrier film; forming a hole reaching the SiC barrier film in the interlayer dielectric film; performing plasma processing on side surfaces of the interlayer dielectric film, the side surfaces being exposed to the hole thereby inherently giving impact to the side surfaces of the interlayer dielectric film to harden the side surfaces; etching the SiC barrier film to allow the hole to reach the inter - connection; and burying a conductive material in the hole, as shown above.

[Re claim 13] Tonegawa also discloses wherein the plasma processing is performed by supplying a gas containing at least He gas into a processing chamber (See par. 0068] ).

[Re claims 14 and 16] APA also discloses wherein a low-dielectric-constant film is formed as the interlayer dielectric film; [Re claims 17 and 19] wherein a film selected from the group consisting of a porous silica film, SiOC film, porous SiOC film, SiOCN film, and porous SiOCN film is formed as the interlayer dielectric film (see Fig. 8A and corresponding text].

[Re claims 20 and 22] Tonegawa also discloses wherein a single damascene method is used, and the hole is formed as a wiring trench; [Re claims 23 and 25] wherein a dual damascene method is used, and the hole is formed as a wiring trench and as a via hole (see Figs. 6A-9C).

Therefore, at the time of the invention, it would have been obvious to combine APA with Tonegawa to obtain the invention as specified in claims 2-7, 12-14, 16, 17, 19, 20, 22, 23, and 25.

4. Claims 8-11, 15, 18, 21, and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over APA in view of Tonegawa, as applied above, and further in view of Ryuzaki et al. (USPN 6777325, hereinafter "Ryuzaki").

The combined teaching of APA and Tonegawa discloses substantially the limitations of claims 8-11, 15, 18, 21, and 24, as shown above.

But it fails to disclose expressly [Re claim 8] the plasma processing forming an organic film on the side surfaces of the interlayer dielectric film; [Re claim 9] wherein the plasma processing is performed by supplying a gas containing carbon and fluorine into a processing chamber; [Re claim 10] the step of forming an SiO<sub>2</sub> film on the interlayer dielectric film, between the step of forming the interlayer dielectric film and the step of forming the hole in the interlayer dielectric film, wherein the hole is also formed in the SiO<sub>2</sub> film in the step of forming the hole in the interlayer dielectric film, and the plasma processing is performed such that no organic film is formed over the SiO<sub>2</sub> film; [Re claim 11] wherein C<sub>4</sub>F<sub>6</sub> gas is used in the step of performing the plasma processing and in the step of etching the SiC barrier film.

However, the missing limitations are well known in the art because Ryuzaki discloses the use of CF<sub>4</sub>, CHF<sub>3</sub>, C<sub>2</sub>F<sub>6</sub>, C<sub>4</sub>F<sub>8</sub> instead of conventional plasma treatment to achieve smaller degradation in dielectric constant (See col. 8, lines 24-36). In the combined teaching of APA, Tonegawa, and Ryuzaki, all the claimed limitations are met.

A person of ordinary skill is motivated to modify APA and Tonegawa with Ryuzaki to obtain less reduction in dielectric constant.

Therefore, at the time of the invention, it would have been obvious to combine APA and Tonegawa with Ryuzaki to obtain the invention as specified in claims 8-11, 15, 18, 21, and 24.

### ***Conclusion***

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha T. Nguyen whose telephone number is (571) 272-1678. The

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examiner can normally be reached on Monday-Friday from 8:30AM to 6:00PM, except the first Friday of each bi-week. The telephone number for Wednesday is (703) 560-0528.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael S. Lebentritt, can be reached on (571) 272-1873. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



**HA NGUYEN  
PRIMARY EXAMINER**

6- 24- 05